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REMARKS/ARGUMENTS

Claim Amendments

By the amendments presented herein, independent process Claim 1 is rewritten to recite an initial new Step (a) which describes the permissible sources of the C₄ olefin feedstream being processed in accordance with the claim. Support for characterization of the possible sources of the initial C₄ olefin feedstream is found in Paragraph [0003] of the originally filed application. In light of the addition of a new Step (a), the original Steps (a), (b) and (c) of Claim 1 are re-lettered as Steps (b), (c) and (d).

Also by the amendments presented herein, Claim 1 is further rewritten to characterize the initial C₄ olefin feedstream as including linear 1-butene as shown in the original specification example and to provide concentrations for the amounts of butadiene and isobutene impurities in this feedstream as set forth in Paragraph [0025] of the original specification.

Also by the amendments presented herein, Claim 1 is further rewritten to indicate that the butene stream recovered in Step (d) of the claimed process is enhanced in 1-butene purity in comparison with the initial C₄ olefin feedstream. Support for this amendment is found in Paragraph [0044] of the original specification.

Also by the claim amendments presented herein, Claim 32 is rewritten editorially to correct an antecedent basis problem.

Upon entry of the claim amendments presented herein, Claims 24-28 and 30-36 remain in the application. No additional claims fee is due as a result of these amendments.

Invention Synopsis

As presently claimed, the invention herein is directed to a process for removing butadiene and isobutene impurities from an initial C₄ olefin feedstream derived from a cracking (steam, catalytic naphtha or FCC) operation or from the conversion of methanol to olefins. Such an initial C₄ olefin feedstream contains linear butene including 1-butene

and specific recited concentrations of butadienes and isobutenes. This initial C₄ feedstream is first contacted under hydrogenation conditions with a hydrogenation catalyst to selectively reduce the amount of butadiene therein. The olefin stream from this hydrogenation step is then contacted under oligomerization conditions with an oligomerization catalyst that selectively oligomerizes the isobutene in this stream to higher chain length hydrocarbons, e.g., dimers and trimers of isobutene. The olefin stream from the oligomerization step is then sent to a C₄ recovery section wherein a butene stream enhanced in 1-butene purity (in comparison with the initial C₄ feed) is recovered.

Formal Matters

Claims 34 has been rejected under 35 USC §112, Second Paragraph, as allegedly indefinite as lacking clear antecedent basis for the term "said crystalline molecular sieve." Claim 34 has been rewritten herein to characterize the catalyst as being a "solid acid catalyst" selected from certain types of crystalline molecular sieves. There is clear antecedent basis in Claim 24, from which Claim 34 depends, for the term "solid acid catalyst." This Claim 34 amendment thus obviates this rejection under 35 USC §112, Second Paragraph.

Art Rejections

Rejection Over Marchionna et al

Claims 24, 25, 27, 28, 33, 35 and 36 have been rejected under 35 USC §103(a) as allegedly being unpatentably obvious in light of Marchionna et al (U.S. Patent Publication No. 2004/0010171, hereinafter "Marchionna"). The Examiner contends that the Marchionna disclosure of the hydrogenation and oligomerization steps carried out on certain of the Marchionna C₄ hydrocarbon streams suggests the C₄ olefin stream purification process of applicants' rejected claims. Such a rejection is respectfully traversed as it would apply to the claims as amended herein.

Marchionna discloses a process for production of saturated hydrocarbons with high octane number starting from mixtures of n-butanes and isobutanes. The saturated butanes ("field butanes") which provide the starting stream in Marchionna are first dehydrogenated to form butenes along with some butadienes. The Marchionna process stream is then hydrogenated to "selectively" convert the butadienes therein to butenes. The stream from this hydrogenation step in Marchionna is then sent to a dimerization step wherein isobutene in the process stream is converted to primarily to dimers but also to other oligomers. The dimers and other oligomers are separated and further processed, thereby leaving a C₄ stream mainly consisting of isobutane, n-butane and butenes. This remaining stream is then further processed to remove the butenes therefrom, leaving only saturated hydrocarbons.

It is respectfully submitted that there are several features of applicants' C₄ olefin stream purification process which are neither taught nor suggested by Marchionna. In the first place, Marchionna fails to disclose or suggest realization of a C₄ olefin stream which is provided from cracking or methanol conversion operations as now required in applicants' process. The olefin stream which is hydrogenated and then dimerized in Marchionna comes from the dehydrogenation of butanes, and certainly not from any cracking or MTO procedures. Marchionna is furthermore completely silent as to the amounts of butadiene and/or isobutenes relative to the amounts of linear butenes and saturated hydrocarbons in this stream from the dehydrogenation step. In short, the types of initial C₄ olefin feedstreams now specified for use in applicants' process are simply not suggested by Marchionna.

Secondly, the hydrogenation step conducted in Marchionna is clearly not designed to produce the same kinds of C₄ olefin stream produced after the hydrogenation step in applicants' process. Marchionna notes in Paragraph [0036] the desirability of hydro-isomerizing some of the 1-butenes to 2-butenes during hydrogenation. The objective in applicants' process, on the other hand, is to enhance the purity of 1-butene in the ending C₄ olefin stream. Hydrogenation to convert 1-butene to 2-butene by

concurrent hydro-isomerization in Marchionna is simply not consistent with the objectives of applicants' C₄ olefin purification process as now claimed.

In short, the different source of the Marchionna C₄ hydrocarbons, the different type of steps used to prepare the olefin stream which is then hydrogenated and dimerized in Marchionna and the different purpose of the overall Marchionna process renders the Marchionna patent publication not suggestive or predictive of the specific essential elements now set forth as process steps in applicants' claims as amended herein. Accordingly, continued rejection of amended Claims 24, 25, 27, 28, 33, 35 and 36 under 35 USC §103 over this Marchionna reference would be improper.

Rejection Over Marchionna in view of Polanek et al

Claims 26, 30 and 34 have been rejected under 35 USC §103(a) as allegedly being unpatentably obvious over Marchionna in view of Polanek et al (U.S. Patent No. 5,227,553, hereinafter "Polanek"). The Examiner contends that it would have been obvious to use the specific conditions and catalysts of Claims 26, 30 and 34 in light of the Polanek disclosure of hydrogenation of butadiene using supported catalysts, hydrogen amounts and hydrogenation conditions similar to those of the rejected claims. Such a rejection is also respectfully traversed as it would apply to the claims as amended herein.

Polanek discloses hydrogenation of hydrocarbon cuts containing large amounts of butadiene. The objective in Polanek is to hydrogenate butadiene without causing a significant amount of isomerization of 1-butene to 2-butene and without producing large amount of isobutane.

It is respectfully submitted that the Polanek reference has been combined with Marchionna essentially in hindsight due to the fortuitous similarity of the hydrogenation catalysts and conditions of Polanek to certain of those recited in applicants' claims. As noted hereinbefore, one objective in Marchionna is to hydrogenate butadiene and to provide a desirable amount of hydro-isomerization of 1-butene to 2-butene at the same time. It is also desirable in Marchionna to eventually realize large amounts of isobutane in the C₄ stream. Polanek, with its objective to inhibit isomerization of 1-butene to 2-

butene and to inhibit isobutane production would never be turned to by the skilled artisan reading Marchionna and wanting to improve Marchionna consistent with its objectives.

In short, there is no motivation to combine the teaching of Polanek and Marchionna, and there is every motivation not to. Accordingly, continued rejection of applicants' amended Claims 26, 30 and 34 under 35 USC §103 over the Marchionna/Polanek reference matrix would be improper.

Rejection Over Marchionna in view of Sakurada et al

Claims 31 and 32 have been rejected under 35 USC §103(a) as allegedly being unpatentably obvious over Marchionna in view of Sakurada et al (U.S. Patent No. 4,454,367, hereinafter "Sakurada"). The Examiner contends that it would have been obvious to use the mordenite-based oligomerization of isobutene as disclosed by Sakurada in the process of Marchionna in order to realize the process of applicants' Claims 31 and 32. Such a rejection is also respectfully traversed as it would apply to the claims as amended herein.

Sakurada discloses oligomerization of isobutene in the presence of linear butenes in order to be able to separate the isobutene from the linear butenes. Oligomerization catalysts and conditions similar to those of applicants' Claims 31 and 32 are also disclosed in Sakurada. As with the Polanek hydrogenation, one objective of Sakurada is to identify catalysts and conditions which effect the desired oligomerization without causing significant isomerization of 1-butene to 2-butene.

Applicants respectfully submit that the Sakurada patent is not properly combined with Marchionna for the same reason discussed above that Polanek is not properly combinable with this primary reference. Again, Marchionna wants to promote isomerization of 1-butene to 2-butene (at least during hydrogenation) while the objective of Sakurada is to prevent this kind of isomerization (at least during oligomerization). Given this divergence of objectives, the skilled artisan would never combine Marchionna and Sakurada as the Examiner suggests. Thus the Section 103 rejection of Claims 31 and 32 over this reference matrix is also improper.

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CONCLUSIONS

Applicants have made an earnest effort to place their application in proper form and to distinguish their claimed invention from the applied prior art. WHEREFORE, reconsideration of this application, entry of the claim amendments presented, withdrawal of the claim rejections under 35 USC §112, and 35 USC §102(b), and allowance of the claims remaining in the application, are all respectfully requested.

Any comments or questions concerning the application can be directed to the undersigned at the telephone number given below.

Respectfully submitted,

Date: 1/16/07

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